partment of agriculture, if this information were only coordinated according to the needs of such a research.

Secondly, to find and then to solve, one by one, the problems of dynamical climatology.

Working along this line and leaving aside, for the present, the continuation of my study on modes of formation and progressive displacements of the thermopleions and antipleions,[1] this study being extremely difficult, I found simpler and more fundamental phenomena by drawing maps of the annual departures of atmospheric pressure.

These maps led me indeed to most unexpected conclusions.

Considering the data of the tables of "barometric pressure" of Sir Norman Lockyer, and utilizing the departures given in Bigelow's report on atmospheric pressure, as well as those published in the annual summaries of the *Monthly Weather Review,* I drew curves showing the geographical distribution of equal departures.

I found that, with few exceptions, the areas of positive and negative departures displace themselves from east to west, from the Atlantic across America toward the Pacific. In reality, however, the movements of the areas of hypo- and hyper-pressure are very complicated, there being generally two distinct directions of propagation simultaneously apparent. Some maps show clearly the existence of intercrossing waves coming from beyond the northeast and southeast of the United States.

These waves are extraordinary because of their slow progress. To verify the fact that waves of hyper- and hypo-pressure of the map of a given year are really those of the preceding year displaced westward, I have calculated consecutive annual means.

The diagrams of these figures—for stations situated along the presumed path of a center of too low or too high annual pressure—show that it is really with a wave movement, of a particular kind, that we have to deal.

I shall not dwell on the details, this being but a preliminary notice of a paper which will be published in the *Bulletin of the American Geographical Society.* I must state, however, that my method of utilizing consecutive means, which makes it possible to draw yearly maps from month to month, will enable me to foresee the changes which will occur.

To know how far this method may be applied to forecast seasonal distribution of pressure, I must first investigate the yearly variations of pressure, and calculate the consecutive means of many series of observations, to find out if there is not a periodicity in the long-range atmospheric waves.

From the discussion of annual maps it appears most probable that the amplitudes of those waves increase and decrease in harmony with the sun-cycle of about eleven years.

Henryk Arctowski

New York

[1] Arctowski, "L'enchaînement des variations climatiques," Bruxelles, 1909.

COLLEGIATE INSTRUCTION

The Committee on College Instruction of Section L, of the American Association, recently ordered the publication, if practicable, of certain samples of the facts obtained in a study of (1) the size of classes (a "class" being defined as a group of students dependent upon one teacher for instruction in a course) and of (2) the actual work done by individual students in fulfilment of the requirements for the A.B. degree. By the courtesy of the editor of Science, these facts are now printed.

Size of Classes

In almost all colleges that report the conditions of instruction in this particular, there is an enormous variability in the size of the groups taught by a single teacher in undergraduate courses. Within the same institution the number will commonly range from three or even fewer to a number equal to a fifth of the entire student body. The facts in this regard have been reported, though not every year, and not without many ambiguities, by Boston University, Bowdoin, Brown, Bryn Mawr, University of California, Harvard, Johns Hopkins, Stanford, Oberlin, Radcliffe, University of Texas, Tufts, Western Reserve,

Williams and probably by a number of other institutions.

Because of the ambiguities of the reports in respect to the exact number of sections, the exact share taken by each officer of instruction engaged in a course, the conduct of laboratory and composition courses and the like, it was not possible, without asking much assistance from many colleges, to determine the exact frequencies of classes of all sizes. But the figures of Table I., which are approximately correct, will give a sufficient idea of this enormous variability. It is even greater in large colleges like the University of California, Harvard or Stanford.

TABLE I

Relative frequencies of different sizes of class in American colleges, a class being defined as a group taught by only one person. In per cents.

Size of Class	Boston University	Brown	Wesleyan	Bowdoin	Beloit	Knox	Wabash
1–9	16.5	38.9	36.6	22.8	42.5	27.5	82.5
10–19	13.2	26.2	22.8	22.8	25.2	25.0	14.2
20–29	14.8	17.6	19.5	22.8	18.1	12.5	26.4
30–39	11.5	9.5	8.1	9.8	4.7	12.5	14.2
40–49	3.8	2.1	2.4	9.0	2.4	12.5	2.0
50–59	3.8	1.7	4.9	6.5	1.6		
60–69	3.8	2.1	.8	4.1	1.6	3.8	2.0
70–79	4.9	.5		.8	1.6		
80–89	4.9	.5	.8[2]	.8			
90–99	4.9	.2				1.3	
100–109	3.8					3.8	2.0
110–119	3.8	.3		.8[3]	.8		
120–129	2.7	.5					
130–139							
140–149	.5[1]						

There is also great variability amongst institutions with respect to the provision for teaching the same subject-matter. The first- and second-year courses in French and German, for example, are, in one college, given to sections of 13 students and, in another, to sections of 41 students. The first course in philosophy or in psychology is in some institutions divided into sections of 40 students, while in others the entire class of two hundred or more is left to one teacher, with presumably some assistance in the examination of written work. Similar differences exist in the case of all departments enrolling many students. In some institutions the enrollment is less than ten in only a sixth of the classes, while some devote nearly half of the teaching hours of their staff to the conduct of classes of less than ten students.

[1] Also 1.1 at 200 and .5 at 220.

[2] A course in chemistry. Help in the laboratory is probably given by others than the one instructor.

[3] A course in hygiene.

It is not the purpose of this report to discuss this condition of college teaching, but it is the committee's opinion that the following questions are worthy of discussion in college faculties and by those responsible for the financial provision for college instruction.

1. Is not the number of students taught at one time by a single individual in many college courses so great as to reduce that individual's knowledge of the attitude, preparation, difficulties, errors and achievements of his students to almost zero?

2. Is not the number of students taught at one time by a single individual in many college courses so small as to involve an enormous waste of the instructor's time and an improper distribution of the appropriations for teaching?

3. Other things being equal, should not the teaching of more than 40 college students at one time by one person be avoided? Should not any department have reasons of weight for any such case?

4. Other things being equal, should not the use of a quarter or more of a professor's teaching hours for a year for the instruction of fewer than ten students in one undergraduate course counting one twentieth or less of the degree's total requirement be avoided? Should not any department have reasons of weight for any such case?

5. Should not the traditional method of having the ratio which the number of class meetings is to the number of "points" credit the same, regardless of whether the class enrollment is 1, 5, 10, 20 or 100, be abandoned in many of the undergraduate courses enrolling less than 10 students?

6. When, in a college course given annually, the number of students is less than 6, should not the course be offered only once in two years, except for reasons of weight?

The Actual Curricula of Individual Students

The committee gathered 500 complete records of the courses taken for the bachelor's degree by students representing random samplings of the class of 1909 in the following institutions: Beloit (27), Bowdoin (36), Columbia, (21), Cornell (42), Harvard (50), Knox (13), Lake Forest (10), Marietta (10), Princeton (49), Ripon (10), Stanford (20), Wabash (22), Wellesley (22), Wesleyan (38), Williams (40), Yale (95). These were worked over by the chairman into complete tables like Table II. below, the first line of which reads, "Individual A did 18 per cent. of the total work required for the degree, in courses in ancient languages; 18 per cent. of it in courses in modern foreign languages; 13 per cent. of it in English; 5 per cent. of it in philosophy, 32 per cent. of it in history, economics, etc." These complete tables are too long to be printed, but they can not be summarized in lower terms. I give in Tables III. and IV. samples of the answers which may be got from them, using two arbitrary questions about the extent of specialization and superficiality.

TABLE II

Samples of the work done for the A.B. degree by individual students

		Latin, Greek, Sanskrit	French, German, Spanish, Italian	English	Philosophy, Psychology, Logic, Ethics, Anthropology	History, Economics, Government	Physics, Chemistry	Biological Sciences	Geology, Astronomy, Geography	Mathematics	Music, Fine Arts
Cases from Princeton	A	18	18	13	5	32	5		2	6	
	B	30	3	15	7	32	5			6	
	C	32	3	30	5	15	5			6	
	D	18	18	15	5	32	5			6	
	E	18	18	8	5	34	5			6	
	F	20	13	8	5	32	7		2	6	
	G	18	13	25	5	22	5			11	5
	H	18	13	15	5	36	5			6	
	I	23	8	6	5	39	5			6	
	J	20	10	15	12	30	5		2	6	2
Cases from Harvard	A		24	12	3		47	3		6	
	B		18	9		6	41		9	12	
	C	12	6	35	38	6					
	D		68	15		24					
	E	12	12	6	6	12	12			29	6
	F		18	27	15	47	6				6
	G[4]		12	18	15	21	12		3		29
	H	29	12	12	3	35	6		3	9	6
	I[5]		24	15		62		3			
	J[6]		18	18		24	12		18		6

[4] Also 12 architecture and 3 engineering.

[5] Also 6 education.

[6] Also 9 mining and 9 engineering.

TABLE III

	No. of Cases	No. Spending at least 50 Per Cent. of the Total Degree Requirement in:						
		Language and Literature	History, Economics, Etc.	All Natural Science	Engineering	Medicine	Architecture	Law
I. Stanford,	20		1	4	5			(a)
Columbia,	21	5			2	2	1	
Cornell.	42	6	4	7		(a)		(a)
II. Harvard.	50	16	8	3	1			
III. Beloit, Knox, Marietta, Ripon and Wabash.	93	15	3					
IV. Bowdoin,	36	22		2				
Wesleyan,	38	20						
Williams,	40	15						
Wellesley,	22	12		1	See note (b)			
Yale,	95	25	3	1				
Princeton.	49	15						
Total.	506	151	19	18	7 or 7 (a)	2	1	0
						5	1	11 by

(a) If the combination of the *hist. ec. gov.* group with law is counted as one group, and if the combination of science and medicine is counted as one group, we have added 11 cases (8 at Stanford, 3 at Cornell) of the former sort and 5 cases (at Cornell) of the latter sort of specialization.

(b) One case for music and art.

Of these cases of apparent scattering 34 are individuals each giving over three tenths of the total degree-requirement to history, economics, etc., and many of the others represent conceivably

TABLE IV

	Number of Cases	Number not Devoting 20 Per Cent. of the Total Degree Requirements to any one of the Following: (1) Ancient Languages. (2) Modern Foreign Languages. (3) English. (4) Philosophy, etc. (5) History. (6) Economics. (7) Government and Public Law. (8) Physics and Chemistry. (9) Biological Science (10) Other Natural Sciences. (11) Mathematics. (12) Art and Music. (13) Education. (14) Law. (15) Medicine. (16) Engineering. (17) Architecture	Per Cent.
I. Stanford	20	0	0
Columbia	21	0	0
Cornell	42	0	0
II. Harvard	50	6	12
III. Beloit, Knox Marietta Ripon and Wabash	93	16	17
IV. Bowdoin	36	0	0
Wesleyan	38	3	8
Williams	40	2	5
Wellesley	22	0	0
Yale	95	7	7½
Princeton	49	23	47
Total.	506	67	13

closely related work. This is the case, for example, with four of the six cases from Harvard.

For the Committee on Collegiate Education of Section L of the American Association.

EDWARD L. THORNDIKE,
Chairman

TEACHERS COLLEGE,
COLUMBIA UNIVERSITY

THE SEXAGESIMAL SYSTEM AND THE DIVISION OF THE CIRCLE

THE division of the hour and the degree into 60 equal parts, called minutes, and the minute into 60 equal parts, called seconds, keeps fresh in our minds the fact that the ancient Babylonians used 60 as a base of numeration. Less than ten years ago all seemed to agree on the probable origin of this system. It was assumed that the ancient Babylonians supposed that there were only 360 days in a year and hence divided the circle so that one day corresponded to each division. In support of this hypothesis it was pointed out that the ancient Chinese divided the circle into 365¼ parts in their *Tcheou pei,* and that this work could not have been written before 213 B.C.; but at this early date the Chinese were already acquainted with the year of 365¼ days. From the assumption that the circle was divided into 360 equal parts before the origin of the sexagesimal system, and the fact that the radius of a circle can be applied exactly six times as a chord of the circumference, it was easy to account for the base 60.

In recent years this question has received considerable attention and many arguments have been advanced against the given hypothesis as regards the division of the circle. These arguments appear convincing, but it is not so easy to replace the old theory by one which is free from objections. In the third edition of his classic "Vorlesungen über Geschichte der Mathematik" (1907, volume I., page 37) Moritz Cantor accepts the hypothesis that the base 60 was selected as a consequence of the mingling in the Babylonian country of two ancient civilizations, one employing 10 and the other 6 as a base of numeration. In view of the difficulties which this hypothesis entails efforts have been made to find a more plausible one.

Professor Edmund H. Hoppe, Hamburg, Germany, has recently advanced such a hypothesis[1] and has given a large number of historical facts tending to its support. He assumes that the normal angle among the ancient Babylonians was an angle of an equilateral triangle and that it was observed at an early date that six such angles cover the entire area around a point. Hence the number 6 assumed great importance, being regarded to stand for completeness. The base 60 could then have easily resulted from a division of the normal angle into ten equal parts. After this base was established, alongside the much older base 10, the normal angle itself was divided into 60 equal parts and this led to the division of the circle into 360 equal parts.

Whether this hypothesis will be generally accepted remains to be seen. The fact that the

[1] *Archiv der Mathematik und Physik,* Vol. 15 (1910), p. 304.